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(21) International Application Number: PCT/AU89/00186 (22) International Filing Date: 2 May 1989 (02.05.89)  (30) Priority data: PI 8021 3 May 1988 (03.05.88) AU		(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.	
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(54) Title: CYCLONE SEPARATOR			
(57) Abstract			
<p>A cyclone separator for separating a denser component of a liquid mixture from a less dense component thereof, the cyclone separator comprising at least one inlet (26) for the admission of material to be separated and outlets (23, 34) for the respective discharge of the denser and less dense components. An inlet duct (50) is provided by which the liquid mixture, in use, is transmitted into the separator via the or each inlet and there is further provided a heat exchanger (60) through which a heat exchanging fluid passes. The heat exchanger (60) is positioned adjacent the inlet duct (50) so as to effect heat exchange of the mixture passing through the inlet duct. One of the outlets (23, 34) may be operatively connected to the heat exchanger (60) or an auxiliary heat exchanger (68) so that fluid from this outlet passes through the heat exchanger.</p>			

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1 "CYCLONE SEPARATOR"

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3 This invention relates to cyclone separators for  
4 separating a denser component of liquid mixture from a less  
5 dense component thereof.

6 According to the present invention there is provided a  
7 cyclone separator for separating a denser component of a  
8 liquid mixture from a less dense component thereof, the  
9 cyclone separator comprising at least one inlet for the  
10 admission of material to be separated and outlets for the  
11 respective discharge of the denser and less dense  
12 components, an inlet duct by which the liquid mixture, in  
13 use, is transmitted into the separator via the or each said  
14 inlet characterized in that there is further provided a heat  
15 exchanger through which a heat exchanging fluid passes, said  
16 heat exchanger positioned adjacent said inlet duct so as to  
17 effect heat exchange of the mixture passing through said  
18 inlet duct.

19 In one preferred embodiment the cyclone separator  
20 comprises an axially extending separating chamber having  
21 towards one end the aforementioned inlet for admission of  
22 the mixture to the separating chamber, an axially positioned  
23 overflow outlet adjacent that one end defining one of the  
24 outlets. The separating chamber is of generally tapered  
25 form with a relatively larger cross-sectional size at the  
26 aforementioned one end and a relatively small cross  
27 sectional size at an axially positioned underflow outlet  
28 which defines the other of the outlets at the end of the  
29 separating chamber opposite the aforementioned one end. In  
30 use the denser component is directed to the underflow outlet  
31 in a fashion such as to encompass an inner axially  
32 positioned core of the less dense component which is  
33 subjected at least over a substantial part of its length to  
34 a pressure differential causing it to flow to the overflow  
35 outlet.

36 In one preferred embodiment, one of the outlets is  
37 operatively connected to the heat exchanger so that, in use,  
38 the separated component which flows from that one of the

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1 outlets passes through the heat exchanger.

2 In another embodiment, one of the outlets is  
3 operatively connected to an auxiliary heat exchanger which  
4 is positioned adjacent the inlet duct so that, in use, the  
5 separated component which flows from that one of the outlets  
6 passes through the auxiliary heat exchanger.

7 Preferably the underflow outlet is operatively  
8 connected to the auxiliary heat exchanger. Furthermore, it  
9 is preferable that the heat exchanger and/or the auxiliary  
10 heat exchanger are adapted to heat the material in the inlet  
11 duct.

12 Preferably the auxiliary heat exchanger is disposed  
13 upstream of the first mentioned heat exchanger with respect  
14 to the inlet ducts.

15 A preferred embodiment of the invention is further  
16 described with reference to the accompanying drawing, the  
17 single figure of which is a diagram illustrating one form of  
18 the invention.

19 In the drawing, a cyclone separator 10 is shown as  
20 having an outer casing 24 of elongate somewhat cylindrical  
21 form, but tapering from a larger diameter end 10a to a  
22 smaller diameter end 10b. Casing 24 defines an interior  
23 separating chamber 24a which comprises a first generally  
24 cylindrical portion 12 of relatively large diameter  
25 connected to a second portion 14 of elongate tapered form  
26 via an intermediate flow smoothing tapered portion 12a, and  
27 a cylindrical portion 16 connected to the end of portion 14  
28 opposite portion 12. A side inlet 26 is provided for inflow  
29 of material to be separated into the separator at the  
30 location of portion 12 and arranged so that material so  
31 inducted executes a rotational motion about the lengthwise  
32 axis of the separator. This rotational motion causes the  
33 more dense and less dense components of the inlet mixture to  
34 be separated, the more dense component moving lengthwise  
35 along the separating chamber to pass through the portions  
36 12a, 14 and 16 and to emerge via an underflow outlet 23  
37 adjacent end 10b of the separator. The less dense component  
38 emerges from the separating chamber 24a via an axial

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1 overflow outlet 34 communicating with portion 12.  
2 Material to be infed into the separator is passed  
3 thereinto via a duct 50. In order to aid separation of some  
4 materials, it is desirable that the material should be at an  
5 elevated temperature. Thus, a heat exchange 60 is shown as  
6 comprising a coil pipe 62 wound around the duct 50 and  
7 arranged for flow therethrough of suitable heated liquid  
8 whereby to impart, by heat exchange, a raised temperature to  
9 the material passing through duct 50.

10 In order, however, that the amount of heating required  
11 by use of heat exchanger 60 may be minimised, the separator  
12 10 is arranged whereby one of the separated components from  
13 the separator is directed via a pipeline 66 to a further  
14 heat exchanger 68, such as in the form of the coiled pipe 70  
15 shown as extending around duct 50.

16 In use, the material to be separated is passed through  
17 duct 50 and is first heated by residual heat exchange from  
18 the separated component in duct 66 which is directed through  
19 the heat exchange pipe 70. This effects partial heating.  
20 Then, the incoming material is further heated by use of the  
21 heat exchanger 60 before being directed into the separator  
22 10. The separator 10 otherwise operates in conventional  
23 fashion.

24 It has been found that applying heat to oily water  
25 mixtures, for example, assists in separation of these. In  
26 such a case, the separator 10 may be constructed in  
27 accordance with the teachings of United States patent  
28 4,237,006, 4,576,724 and 4,710,299. Another example of  
29 separator which may be used is PCT/AU85/00181. In such a  
30 case, the component which emerges from the underflow outlet  
31 23 or passage through pipeline 66 to heat exchanger 68 will  
32 be predominantly water whilst that emerging from the outlet  
33 34 will be predominantly oil. Separators of the kind  
34 discussed in these patent specifications are most suitable  
35 where there is a high proportion of water compared with oil,  
36 so that there will be a substantial flow through the outlet  
37 23 as compared with the outlet 34. Thus, it is preferable  
38 that the residual heat be recovered and applied for heating

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1 material in duct 50 be the liquid from the outlet 23 rather  
2 than from the outlet 34. However, it would of course be  
3 possible to alternatively arrange the separator so that it  
4 is the liquid from outlet 34 which is directed to the heat  
5 exchanger 68. Again, two heat exchanges may be provided so  
6 that material from both outlets can be directed to heat  
7 exchange for heating material in duct 50. Also, the  
8 described arrangement may be adapted for cooling of incoming  
9 material to be separated, by passing a coolant liquid at low  
10 temperature through heat exchanger 60.

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CLAIMS

1. A cyclone separator for separating a denser component of a liquid mixture from a less dense component thereof, the cyclone separator comprising at least one inlet (26) for the admission of material to be separated and outlets (23, 34) for the respective discharge of the denser and less dense components, an inlet duct (50) by which the liquid mixture, in use, is transmitted into the separator via the or each said inlet (26) characterized in that there is further provided a heat exchanger (60, 68) through which a heat exchanging fluid passes, said heat exchanger (60, 68) positioned adjacent said inlet duct (50) so as to effect heat exchange of the mixture passing through said inlet duct.
2. A cyclone separator according to claim 1 characterized by an axially extending separating chamber (24a) having towards one end (10a) said inlet (26) for admission of the mixture to the separating chamber (24a) an axially positioned overflow outlet (34) adjacent said one end defining one of said outlets said separating chamber, being of generally tapered form with a relatively larger cross-sectional size at said one end (10a) and a relatively small cross sectional size at an axially positioned underflow outlet (23) defining the other of said outlets at the end of the separating chamber opposite said one end, (10a) wherein, in use, the denser component is directed to the underflow outlet in a fashion such as to encompass an inner axially positioned core of the less dense component which is subjected at least over a substantial part of its length to a pressure differential causing it to flow to the overflow outlet.
3. A cyclone separator according to claim 1 or claim 2 further characterized in that one of said outlets (23 34) is operatively connected to said heat exchanger (60, 68) so

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that, in use, the separated component which flows from said one of said outlets passes through said heat exchanger.

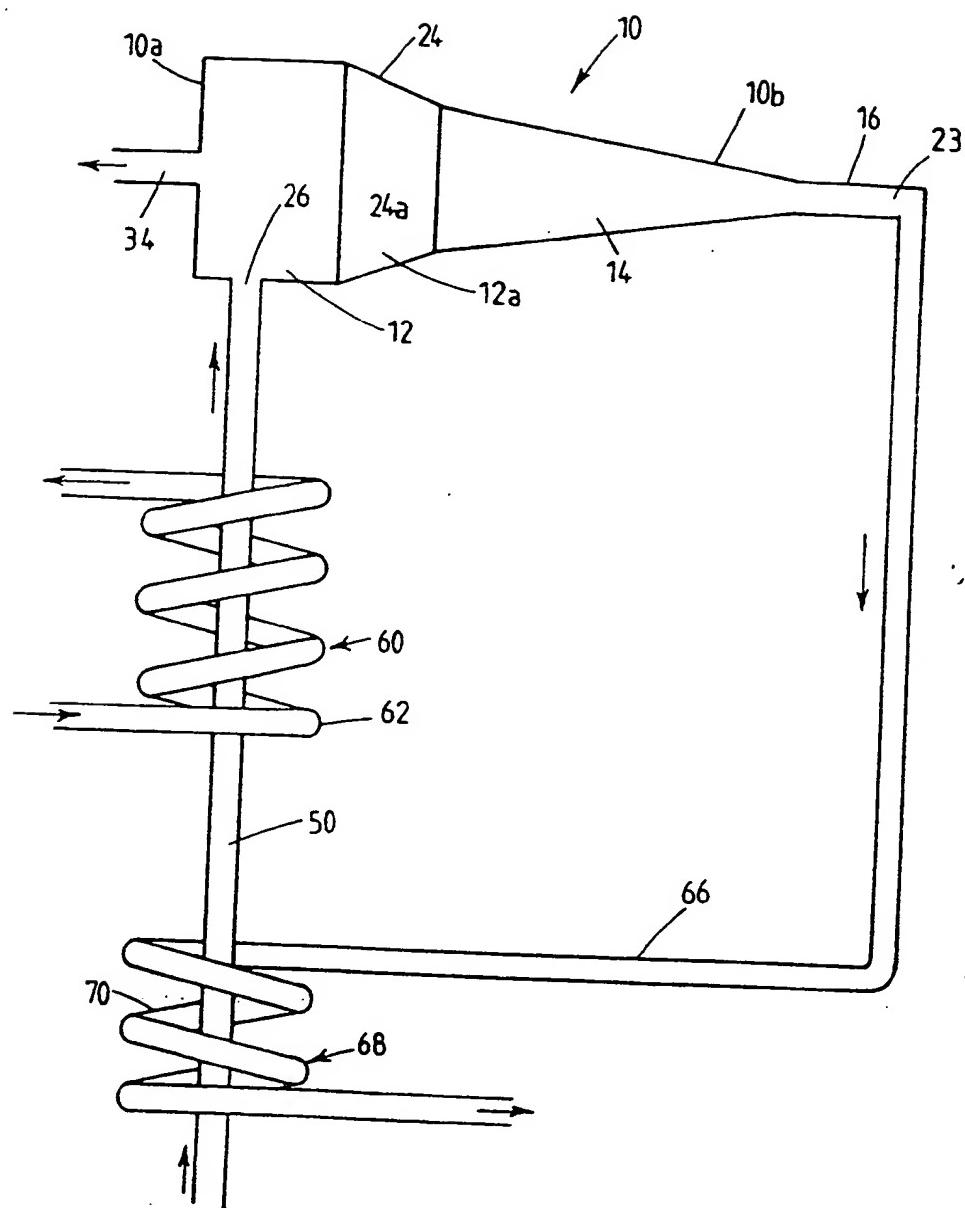
4. A cyclone separator according to claim 1 or claim 2 further characterized in that one of said outlets (23, 34) is operatively connected to an auxiliary heat exchanger (68) which is positioned adjacent said inlet duct so that, in use, the separated component which flows from said one of said outlets passes through said auxiliary heat exchanger.

5. A cyclone separator according to claim 4 characterized in that said underflow outlet (23) is operatively connected to said auxiliary heat exchanger (68).

6. A cyclone separator according to claim 4 or claim 5 further characterized in that said auxiliary heat exchanger (68) is disposed upstream of said heat exchanger (60) with respect to said inlet duct (50).

7. A cyclone separator according to any preceding claim wherein said heat exchanger or said auxiliary heat exchanger are adapted to heat the material in said inlet duct.

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## INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 89/00186

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.<sup>4</sup> B04C 9/00

## II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	B04C 9/00

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched 8

AU : IPC as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No 13
A	AU,A,46753/85 (VORTOIL) 27 February 1986 (27.02.86) Page 8 lines 18-22	
X	EP,A,140769 (CREUSOT-LOIRE) 8 May 1985 (08.05.85)	(1, 3-7)
X	GB,A,2155821 (DEUTSCHE BABCOCK WERKE) 2 October 1985 (02.10.85)	(1-7)
X	WO,A,87/05826 (EINCO OY) 8 October 1987 (08.10.87)	(1-7)
X	WO,A,86/03986 (AHLSTROM) 17 July 1986 (17.07.86)	(1-7)
A	Derwent Abstract Accession no 86-244476/37, Class P41, SU,A,1209260 (SIEB SIBISVERMEINII) 7 February 1986 (07.02.86)	
X	Derwent Abstract Accession no 85-182401/30, Class P41, SU,A,1131539 (ZHDANOV METAL INST) 30 December 1984 (30.12.84)	(1-2)
X	Patents Abstracts of Japan, C-460, Page 60, JP,A,62-136218 (MITSUBISHI HEAVY IND LTD) 19 June 1987 (19.06.87)	(1-2)

- \* Special categories of cited documents: 10    "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
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 "g" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search 3 August 1989 (03.08.89)	Date of Mailing of this International Search Report 11 August 1989 (11.08.89)
International Searching Authority Australian Patent Office	Signature of Authorized Officer R.B. CAMPBELL

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON  
INTERNATIONAL APPLICATION NO. PCT/AU 89/00186

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Patent Document Cited in Search Report	Patent Family Members
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AU 46753/85	BR 8507218 GB 2187401 WO 8601130	DK 1496/86 NL 8520221	FI 870434 US 4764287
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EP 140769	FR 2555468
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GB 2155821	DE 3410143 US 4601734	DK 181/85 ZA 8500672	SE 8406605
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WO 8705826	FI 861224	ZA 8702118
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WO 8603986	AU 53524/86 US 4747852	EP 245268	FI 850134
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